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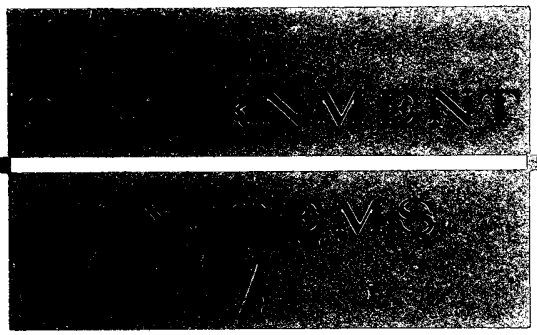

TECHNICAL PROPOSAL

3 AUGUST 1965

WATER POLLUTION SURVEILLANCE INVESTIGATION AND RESEARCH PROGRAM

Prepared for

INTERNATIONAL JOINT COMMISSION
UNITED STATES AND CANADA
WASHINGTON, D.C.

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GOVERNMENT

SYSTEMS

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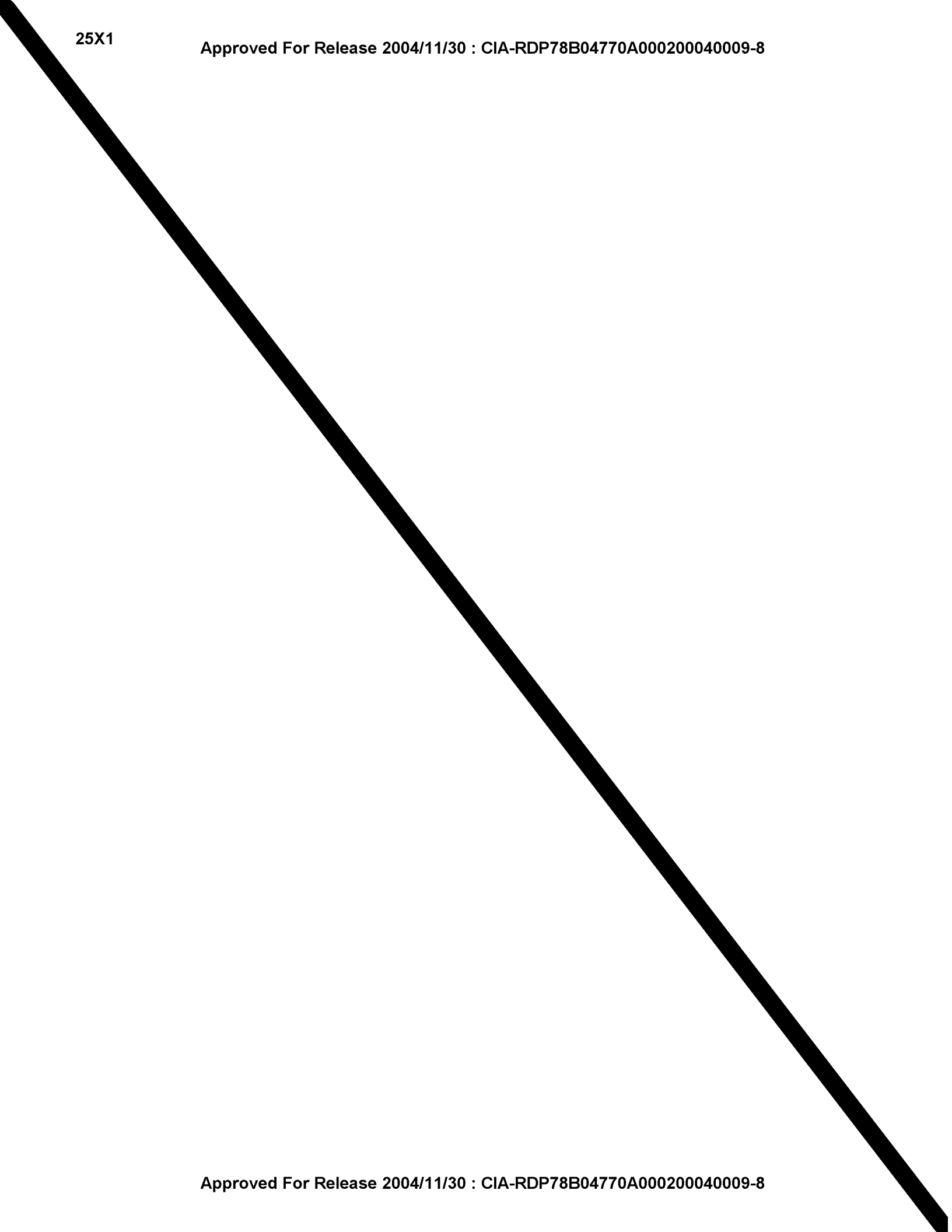

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1. SUMMARY

25X1 This proposal contains [redacted] proprietary recommendations for the conduct of an investigation and research program for the International Joint Commission (United States and Canada) in the field of water pollution surveillance. It is proposed that [redacted] will:

1. Investigate the feasibility of using aerial photography and photointerpretation to detect, identify, and quantify pollution in the border waters between the United States and Canada.

2. Demonstrate the capabilities of aerial photographic imaging and interpretation methods for water quality analysis by:

- Determining the extent of algal bloom conditions at the eastern end of Lake Erie along the Canadian shore near Crystal Beach
- Locating and annotating on a map the sources and areal extent of pollution in the area adjacent to Crystal Beach and Buffalo Harbor, along the Niagara River, along a 10-mile section of the American shore of Lake Ontario, and along a portion of the St. Lawrence River
- Mapping the dispersion of effluents from detected sources of pollution.

25X1 [redacted] believes that the proposed demonstration and research program will be of significant value to the International Joint Commission. [redacted] feels that aerial photographic and photointerpretation methods, when fully developed, can save both time and money for the Commission in discharging its vital responsibility to the United States and Canada. 25X1

2. INTRODUCTION

Identical letters from the United States Secretary of State and the Canadian Secretary of State for External Affairs, dated April 1, 1946, directed the International Joint Commission to investigate specific water quality problems in the border waters. These water quality problems were found to have created a serious health menace, and to have caused adverse economic effects. On receipt of the letters, the Commission appointed a board of sanitary experts to act as technical advisors to the Commission. The board still serves in this capacity.

Early in 1965, the Commission was directed by the two Governments to investigate recent water pollution threats along the Red River (of the North) and along the margins of the Great Lakes.

25X1 [redacted] learned of the existing water pollution problems and of the directive to the Commission through the good offices of Congressman Odin Langen (R), Minnesota, 7th District, which borders the Red River. 25X1

Congressman Langen advised that Mr. William A. Bullard, Secretary, United States Section, should be consulted with regard to the existing problems. [redacted] contacted Mr. Bullard in March 1965. 25X1 A meeting was held later that month, attended by:

Mr. W. A. Bullard
Mr. L. F. Warrick, U.S. Public Health Service
25X1 [redacted]

The potential of an aerial reconnaissance system for water quality analysis was demonstrated, using photographic slides which [redacted] had collected through the years. Discussions were held in which the [redacted] representatives advocated that a feasibility study be conducted to test and evaluate aerial photographic methods for assessing the quality of border waters. This proposal is a further development of the ideas and recommendations generated during the discussions. 25X1 25X1

3. STATEMENT OF THE PROBLEM

The International Joint Commission (United States and Canada) has as its purpose the prevention of disputes regarding the use of boundary waters, settlement of questions between the United States and Canada involving rights, obligations, or interests of either country along the common frontier, and provision for the adjustment and settlement of all such disputes and questions as may arise.

The Commission has jurisdiction over all cases involving use, obstruction, or diversion of boundary waters between the United States and Canada, waters flowing from boundary waters, and waters at a lower level than the boundary in rivers flowing across the boundary. The Commission acts to prevent pollution of boundary waters and waters crossing the boundary.

The detection and subsequent correction of existing or incipient sources of pollution is an important phase of the Commission's work. The boundary waters consist of thousands of square miles of lakes and rivers. The problem of maintaining surveillance of these waters is one of considerable magnitude. The extent of the boundary waters, and the difficulty of access to certain portions of them, tend to lessen the effectiveness of surface monitoring or inspection operations. A method is required that will enable the Commission to maintain regular surveillance, at frequent intervals, of all boundary waters in which pollution is, or can become, a menace to the two nations.

This requirement logically calls for investigation of the feasibility of using aerial photography and photointerpretation to provide constant surveillance capability economically and effectively.

4. TECHNICAL APPROACH

25X1 [redacted] suggests that recently developed, special purpose aerial films, special photographic processing techniques, and sophisticated methods of photointerpretation and image analysis can be applied to the problem of maintaining surveillance of the sources and extent of existing or incipient water pollution. These techniques and methods will not replace, but will augment the coverage of ground supply methods, thus reducing much field work, while improving the Commission's program, at a saving in time and money.

25X1 [redacted] approach is based on the fact that many conditions that affect or indicate the quality of water in lakes and streams can be detected more readily through interpretation of aerial photographs than by observers on the scene because:

1. Human vision is spectrally limited. The portion of the electromagnetic spectrum that is visible to humans extends from about 400 to about 700 millimicrons, whereas the portion to which special photographic emulsions are sensitive extends from about 300 to about 1500 millimicrons. Thus, many of the indicators of pollution in water that are indistinguishable by the unaided eye can be recorded photographically.

2. Humans do not possess the spatial resolution capability of modern photographic systems. The unaided human eye can resolve about 4.5 lines per millimeter at a contrast of 2:1. Aerial photographic systems can resolve better than 100 lines per millimeter at this ratio. Thus, small details in the scene that might be invisible to a human on the site can be detected and identified in a photograph.

3. The photograph is a permanent record of the scene. The detail it records can be studied at leisure. The study can be aided by the use of magnifying devices, stereoscopes, and other aids. The human's limited ability to retain mental images of all the details in the scene and their spatial relationships is no longer a problem.

4. The permanence of the photographic record, together with the geometric fidelity of the components of the image, make possible the determination of areas, distances, and vectors with a degree of accuracy much greater than is usually possible from ground observations. Further, it is possible to observe changes in a given situation by comparing photographs made at different times.

5. Imagery depicting specific conditions in water can be enhanced so that it may be analyzed more thoroughly. Complex photographic laboratory techniques are

required to emphasize certain features of the imagery while subduing others. Figs. 4-1 and 4-2 are color photographs which illustrate how photographic enhancement accentuates details that an observer on the site might be unable to differentiate from the surroundings. These photos show the flow of heated coolant water from a thermal electric plant and a flow of effluent from a sewage treatment plant. The photos were made at flood tide on the Potomac River just south of Washington, D.C. It is probable that the flows actually come in contact during ebb and flow, thus creating a pollution barrier across the river. It is doubtful that this condition could be effectively assessed by other than aerial photographic techniques.

6. Special film and filter combinations can be used to alter the apparent colors of specific substances in the water, thus making them stand out vividly against the surrounding water. Fig. 4-3 is a color photograph illustrating the blood-red appearance of green Chlorophyta photographed on infrared color film (Kodak Ektachrome Infrared Aero film, type 8443).

25X1 [redacted] proposes to demonstrate the validity of the preceding statements by performing a research study involving the analysis of aerial photography of an area including portions of Lake Erie, the Niagara River, Lake Ontario, and the St. Lawrence River. The photography will be obtained on several different types of aerial film, various film-filter combinations will be used, and otherwise identical photos will be obtained at various photographic scales.

The analysis will be aimed at providing quantitative and qualitative data in such areas as the following:

1. Spectral analysis and manipulation to determine which combination or combinations of films and filters provide the most useful imagery of different water quality indicators
2. Determination of photographic scale and resolution parameters required to provide the optimum image quality or interpretability
3. Identification and description of specific indicators of the different water quality conditions
4. Determination of the effects of sun angle, atmospheric conditions, and other related factors on the interpretability of water quality photography
5. Analysis of utility of aerial photos in detecting sources of pollutants at their point of entry, and in determining areal extent of pollution
6. Analysis of utility of time lapse photography in detecting or measuring dispersion of effluents, etc.
7. Establishment of planning factors for use in conducting one-time and/or repetitive aerial surveys of border waters for pollution detection.

Aerial photos will be made of the areas shown in Appendix A, and along flight lines as described in the following paragraphs.

1. Photographs will be taken at scales of 1/5,000, 1/10,000, and 1/20,000 along the shore of Buffalo Harbor from Bay View to the Peace Bridge which crosses the Niagara River between Fort Erie, Ontario, and Buffalo, New York.

Fig. 4-1 — Flows of heated coolant water from the Potomac Electric Power Company's Potomac River thermal electric generating station and treated effluent from the Washington, D.C. Blue Plains' sewage treatment plant, copied from standard aerial color film.

Fig. 4-2 — Photographic enhancement of subject in Fig. 4-1 by modifying the color responses in the original aerial color photograph. Note that some water details can be seen more vividly. Note also that effluents from the two sources almost create a barrier across the Potomac.

Fig. 4-3 — Oblique aerial photograph obtained using Eastman Ektachrome Infrared Aero Film, type 8443. Note the red patch in the water near the inlet canal. This is caused by intense infrared reflection from green (Chlorophyta) algae in the water. Note the milky tone near the center of the pond. This tone is characteristic of dead or dying vegetation and algae.

2. Photographs at scales of 1/10,000 and 1/20,000 will be made of the Canadian shore of Lake Erie over the Crystal Beach area.

3. Photographs will be taken along both channels of the Niagara River around Grand Island, then downstream along the Niagara River to the point at which the river discharges into Lake Ontario. These flight lines will be extended along the U.S. shore of Lake Ontario past the mouth of Tuscarora Bay near Wilson, New York.

4. Photographs at a scale of 1/10,000 using Aerial Anscochrome D-200 film will be taken along the St. Lawrence River from the eastern end of Lake Ontario to a point approximately 15 miles beyond the limit of the U.S. border. The photography will extend beyond the U.S. boundary so that any visible pollutional effects which may originate along the U.S. shore can be imaged.

Photographs along all flight lines will be taken using Aerial Anscochrome D-200 film, and Eastman Ektachrome Infrared Aero film, type 8443. Standard black and white mapping photos of the same areas at a scale of 1/20,000 will be obtained from Government agencies. High resolution black and white photos, at scales of 1/10,000, 1/20,000, and 1/40,000, will be made along the shores of Buffalo Harbor using Eastman High Definition Aerial film, type 4404 or SO-243, and a Wratten 16 filter (or equivalent).

The photographs will be analyzed and all evidence of existing or incipient pollution will be annotated on maps, charts, or photomosaics. Written descriptions and photographs of indicators will be prepared. A comparative analysis will be made of the ability of the various film-filter combinations and the various scales to record interpretable information. A recording microdensitometer will be used to delineate the extent of pollutant dispersion in selected areas.

Imagery of selected areas will be enhanced to accentuate the appearance of specific effluents. Tests will be made to develop specific procedures to enhance selected types of pollution conditions. This will be done by photographically reproducing the full color and false color film on color film using selected filters. Spectral analytical techniques will include photocopying selected sections of the color and false color film through selected narrow bandpass filters and measuring image densities on the negatives which are obtained, using a recording microdensitometer.

Data obtained by ground observations will be compared against the results of the photointerpretation study. These data will be used in an attempt to measure such anomalous conditions as differences in tone or color, which may indicate differences in dissolved oxygen content or in water clarity (an inverse measure of turbidity), and the extent and pattern of convection slicks.

The results of the laboratory experiments will be verified by field visits to the site following the photointerpretation phase.

Monthly progress reports will be submitted; a final technical report will provide quantitative and qualitative data on the factors listed above, and it will be illustrated by:

1. Large scale maps on which all detected sources of pollution and flows of polluted water will be annotated

2. Photomosaics annotated with the same information
3. Photographs of selected typical pollution conditions; stereograms will be prepared where appropriate
4. Comparative photographs showing the effects on pollution detection of various film and filter combinations and laboratory enhancement techniques.

The final report will provide definitive information as to the photographic scale and resolution and the film-filter combinations recommended for obtaining photographs of various types of pollution. The report will define the operational parameters, estimated costs, and personnel requirements of an aerial photographic system for maintaining surveillance of water quality conditions in the boundary waters.

Photography obtained in conducting this study will be retained in [redacted] Analysis Center's film library, and will be available to all interested persons, as authorized by the Joint International Commission, for further research and investigation. 25X1

5. WORK PLAN

25X1 [redacted] proposes to conduct the program described herein by accomplishing the following tasks:

1. Procurement of Photography. [redacted] will obtain the services of a subcontractor who will conduct the necessary aerial photographic operations in accordance with specifications to be developed by [redacted] will purchase prints, positive transparencies, or duplicate negatives of existing photography of the test area selected from the holdings of various Government aerial film libraries. 25X1 25X1

2. Field Data Collection. [redacted] will, in cooperation with the International Joint Commission, collect data on water pollutants and water quality in the test area through on-site observations or through research of available reports and other documents. This task will be accomplished in two phases: Phase 1 will be concurrent with the procurement of photography. Phase 2 will be accomplished after the initial photointerpretation and analysis tasks described below have been completed. 25X1

3. Data Analysis and Correlation. [redacted] will perform a detailed and exhaustive analysis of the photography procured under task 1, searching for evidence or indicators of: (1) pollutants being discharged into, or present in, the waters of the test area, and (2) sources of these pollutants. The analysis will be performed using advanced photointerpretation techniques, spectral manipulation and analysis of the photography, and microddensitometric studies. The results of the analysis will be correlated with field data collected under task 2. 25X1

4. Preparation of Reports. The results of the data analysis and correlation will be documented in the form of: (1) annotated maps, single photographs, photomosaics, or other appropriate graphics; (2) illustrations of typical and atypical indicators of pollutants; (3) comparisons of different types of photography of selected areas; and (4) textual materials describing the technical aspects of the research program and [redacted] conclusions and recommendations regarding the feasibility of using aerial photography and photointerpretation techniques for surveillance of existing or incipient pollution of lakes, rivers, or other bodies of water. 25X1

5. Photographic Library Service. [redacted] will retain the photography used in this project in its Data Analysis Center's film library, where it will be available to persons or agencies authorized access to it by the International Joint Commission. 25X1

6. STATEMENT OF WORK

25X1 [redacted] agrees to provide all engineering, labor, tools, material supplies, and services as necessary to accomplish the following:

1. Procure, through a subcontractor, aerial photography of the test area recommended by [redacted] and concurred in by the International Joint Commission; photography will conform to specifications established by [redacted] 25X1

2. Procure (from Government aerial photography libraries) prints, duplicate negatives, or positive transparencies of selected photographs covering the test area

3. Produce photographic prints and other photographic reproductions as required to perform tasks 4 through 7 described below, and to illustrate various reports

4. Perform a detailed photointerpretation and spectral analysis of the photography of the test area searching for evidences or indicators of pollutants being discharged into waters of the test area, or present in the waters, and sources of such pollutants

5. Record the findings of the photointerpretation and spectral analysis on suitable maps, single photographs, photomosaics, or other graphics, and in textual form

6. Provide monthly progress reports

7. Provide a final report describing the technical aspects of the program and presenting [redacted] conclusions and recommendations on the feasibility of, and methods for, using aerial photography and photointerpretation techniques to conduct surveillance and analysis of existing or incipient pollution in rivers, lakes, and other bodies of water of concern to the Joint International Commission, and including suitable illustrations, examples, and other materials to support the conclusions and recommendations

7. RELATED EXPERIENCE

25X1 The [redacted] under whose cognizance this project would be conducted, was established in 1964 as a part of [redacted] Government Systems organization. 25X1 Under the terms of its charter, the center offers contract services based on special capabilities in photogrammetry, geodesy, remote sensor record analysis, photointerpretation, and photographic reproduction. Specifically, the center is manned and equipped to provide services and products based on the following:

- Analysis and interpretation of photographic and other remote reconnaissance sensor records. Development and improvement of data extraction and handling techniques. Preparation of specifications for the design of image analysis and interpretation equipment.
- Analysis of photogrammetric and geodetic problems inherent in the exploration of the earth, the moon, and the planets from various types of platforms. Performing systems analysis to develop specific analytical solutions and equipment performance specifications. Testing of such solutions and equipments.
- 2[redacted]X1 Calibration and testing of [redacted] manufactured photogrammetric and photointerpretation equipment and technology.
- Reduction of data acquired by remote sensors and the preparation of such end products as target folders, photomosaics, orthophotographs, maps, charts, and other textual and graphic materials.

Projects now under way, or recently completed, at the center include:

- An analysis of the comparative value of black and white, full color, and infrared color photography for the interpretation of vegetation, soil types, cultural features, and drainage.
- An investigation of the optimum photographic materials and photointerpretation techniques for archeological exploration by aerial reconnaissance.
- A study of photographic parameters for an optimum target system for tactical aerial reconnaissance.
- Analysis of photographic materials produced by [redacted] equipment to determine 25X1 image quality, geometric fidelity, and related engineering and design factors.

- Microdensitometric readings of photographic materials produced by advanced sensor devices.
- Investigations of the uses of aerial reconnaissance in water resource studies, with emphasis on the detection of pollutants in rivers and lakes through specialized photointerpretation techniques.
- High accuracy, high precision measurements of grids and reseaus for [redacted] instruments. 25X1
- Studies of the relationships between panoramic photography and frame photography obtained simultaneously, with emphasis on cartographic applications.
- Calibration and operational testing of Itek produced panoramic rectifying printers.

25X1 [redacted] was formed in 1957 in response to critical needs for advancing the state of the art in information technology. In meeting its extensive contractual obligations to the Government, industry, and the military, [redacted] has made substantial contribu- 25X1
tions to the fulfillment of national needs, and has established itself as a leader in the country's photo-optical and information handling industry.

The Government Systems organization, of which the Data Analysis Center is a part, is primarily engaged in design and development programs for both military and non-military customers. The scientists and engineers of this group work as project teams, and apply their knowledge of many scientific and engineering disciplines to the expeditious and economic solution of systems and equipment design problems.

Government Systems personnel were responsible for the first successful panoramic photography from the air and, since that time, the majority of programs undertaken by the group have been directed toward the development of photographic systems and their related ground handling equipments.

25X1 [redacted] broad background in the field of information technology includes such major advances as:

- Development of the world's largest photographic lenses and cameras
- First concept and design of television viewfinders for pilots
- Pioneering in the application of information theory to optical systems
- First accurate tracking of a manmade satellite (Sputnik)
- Research into human factors relating to photointerpretation; design and construction of advanced photointerpretation viewing devices
- Development of optical and electronic image enhancement techniques
- Development of photographic rectifying printers for panoramic photos
- Integration of multisensor equipment in advanced reconnaissance systems

25X1 [redacted] occupies over 1 million square feet of floor space at locations throughout the country. These facilities are devoted to the company's engineering, research, fabrication, marketing, and administrative operations. Net sales and income from contracts exceeded $43,000,000 in 1964.

8. PROGRAM ORGANIZATION

25X1 The [ ] will be the [ ] organization 25X1 25X1
charged with accomplishing the proposed program. The program will be managed by

[ ]

Resumes of key personnel are attached.

Next 4 Page(s) In Document Exempt

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